FIRM/R118
Suppl

LIBRARY
JAN 16 1973
FISH & WILDLIFE SERVICE

Supplement 1 to the Report of the fourth session of the

FAO PANEL OF EXPERTS FOR THE FACILITATION OF TUNA RESEARCH

La Jolla, California, U.S.A., 8 - 12 November 1971

FINAL REPORT OF THE WORKING PARTY ON TUNA AND BILLFISH TAGGING IN THE ATLANTIC AND ADJACENT SEAS

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
ROME, 1972

FAO Fisheries Reports, No. 118 Supplement 1 FIRM/R118 Suppl.1 (En)

FINAL REPORT OF THE WORKING PARTY ON TUNA AND BILLFISH TAGGING IN THE ATLANTIC AND ADJACENT SEAS

SUPPLEMENT 1 TO THE REPORT OF THE FOURTH SESSION OF THE FAO PANEL OF EXPERTS FOR THE FACILITATION OF TUNA RESEARCH

La Jolla, California, U.S.A., 8-12 November 1971

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, September 1972

PREPARATION OF THIS REPORT

This is an edited and amended version of the draft report (FIR:EPFTR/71/4) distributed at the Fourth Session of the FAO Panel of Experts for the Facilitation of Tuna Research.

The report is contribution No. 2796 from the Woods Hole Oceanographic Institution, U.S.A.

Distribution

FAO Department of Fisheries
FAO Regional Fisheries Officers
Members of the Panel of Experts for the Facilitation of Tuna Research and its Working Parties
Members of ACMRR
Regional Fisheries Bodies
Selectors SM

Bibliographic entry

FAO Panel of Experts for the Facilitation of Tuna Research, La Jolla, California, U.S.A., 8-12 November 1971 (1972)
FAO Fish.Rep., (118)Suppl.1:37 p.
Final report of the Working Party on Tuna and Billfish Tagging in the Atlantic and Adjacent Seas. Supplement 1 to the report of the fourth session of the .....

FAO fisheries - working party reports. Thunnidae, Histiophoridae, Xiphiidae - ANW, ANE, ASW, ASE. Tagging and migrations. Research institutions and programmes. Recaptures - biological and statistical data. Recommendations - tag types, tagging techniques, tagging mortality, return of tags, priorities in tagging. Bibliographic information.

CONTENTS

		Page
1.	INTRODUCTION	1
2.	REVIEW OF TUNA AND BILLFISH TAGGING IN THE ATLANTIC AND ADJACENT SEAS	2
	2.1 Summary of tagging programmes	2
	2.2 Bluefin tuna (Thunnus thynnus)	3
	2.3 Albacore (Thunnus alalunga)	13
	2.4 Yellowfin tuna (Thunnus albacares)	13
	2.5 Blackfin tuna (Thunnus atlanticus)	13
	2.6 Bigeye tuna (Thunnus obesus)	14
	2.7 Skipjack (Katsuwonus pelamis)	14
	2.8 Broadbill swordfish (Xiphias gladius)	14
	2.9 White marlin (Tetrapturus albidus)	14
	2.10 Blue marlin (Makaira nigricans)	15
	2.11 Sailfish (Istiophorus albicans)	15
3.	DISCUSSION, RECOMMENDATIONS AND CONCLUSIONS	18
	3.1 Tag types	18
	3.2 Tagging techniques	18
	3.3 Tagging mortality	19
	3.4 Return of tags	19
	3.5 Priorities in tagging	19
4.	TABLES 1 TO 11	20
5.	GENERAL BIBLIOGRAPHY OF TUNA AND BILLFISH TAGGING	31

Digitized by the Internet Archive
in 2025

https://archive.org/details/fao-fisheries-and-aquaculture-report_1972_supplement-1

1. INTRODUCTION

During the Second Session of the FAO Expert Panel for the Facilitation of Tuna Research (EPFTR) in Tokyo, 15-21 August 1966, the Panel recommended the formation of two regional Working Parties for Tuna Tagging, one for the Pacific and Indian Oceans and one for the Atlantic and Adjacent Seas.

The members[1] of the Working Party for Tuna Tagging in the Atlantic and Adjacent Seas, formed according to this recommendation, are as follows:

Mr. F.J. Mather, III (U.S.A.), Convener
Dr. J. de Ciechomski (Argentina)
Mr. J. Collignon (Morocco)
Mr. R.C. Griffiths (FAO, Venezuela)
Mr. J. Hamre (Norway)
Dr. S. Kikawa (Japan)
Mr. E.A. Kwei (Ghana)
Mr. J.C. Le Guen (Congo-Brazzaville)
Dr. S. Moura (Brazil)
Mr. A. Percier (France)
Dr. J. Rodríguez-Roda (Spain)
Mr. G.H. Stander (South Africa)
Mr. S.N. Tibbo (Canada)
Dr. K. Tiews (Germany)
Mr. J. Troadec (Ivory Coast)[2]
Dr. H.Z. Vilela (Portugal)

The Panel formulated the following terms of reference for the Working Parties:

1. To record and follow up any tagging programme being carried out or planned, and inform the Secretary of the Panel, who will give the information wide distribution.

2. To obtain the collaboration of those concerned with the tuna industry (private companies, fishermen, boat owners, fishmongers, canners, etc.) to secure the maximum returns of released tuna tags with adequate recapture data.

3. To encourage actively and develop tagging programmes, and particularly to assist in arrangements for international collaboration in their execution.

In addition the Panel made the following recommendations:

1. Work be confined to yellowfin tuna, bluefin tuna, skipjack tuna and albacore.

2. Research be initiated to determine the efficiency of different tags now in use.

1/ Dr. J.R. Gonzáles, who represented Cuba, has been assigned to other duties, and no successor has been appointed to date.

2/ Presently with FAO, Rome.

3. The plastic dart tag of the Inter-American Tropical Tuna Commission be used as a standard for comparing other tuna tags.

At its Third Session, Cadiz, 7-10 October 1969, the Panel further recommended that:

(a) the Working Parties extend their studies to include the billfishes;

(b) when reporting tag return data in preliminary reports they be a accompanied whenever possible with corresponding total catch data so as to provide some estimate of the expectation of tag returns;

(c) additional research on the development of more efficient tuna tags. The Panel noted, however, the need to compare the efficiency of these newly developed tags with the standard plastic dart tag of IATTC as recommended during the previous Panel session in Tokyo;

(d) the Working Parties, to the best of their ability, attempt to set up guide lines for the use of the most efficient type of tag of those currently available, for certain sized fish of a particular species captured by a specific type of gear;

(e) the amount of a tag reward be uniform within the country in which the tag is returned, regardless of where the tag was released, and further that the amount of the reward not be placed on the tag.

The Working Party has carried out all of its work by correspondence.

The Working Party prepared an Interim Report (Mather et al., 1969) which was published in the report of the Third Session of the Panel (FAO Fish.Rep.80:50-69)

A draft revision of the interim report was used as an Information Document at the meeting of the Sub-Committee on Stock Identification under the Standing Committee on Research and Statistics of the International Commission for the Conservation of Atlantic Tunas (ICCAT) at Lisbon in April, 1971. The terms of reference of that Sub-Committee include those of this Working Party, and it was therefore decided during the Fourth Session of the Panel in La Jolla, 8-12 November 1971 that the Working Party should be disbanded and that the Final Report of the Working Party should be published.

Since little progress has been made by the Working Party under items (2) and (3) of the terms of reference, this report is essentially a review of Atlantic tuna and billfish tagging up to October 1971, and of plans for the future. In the interests of making this as complete as possible, some information from sources other than the members of the Working Party has been included. The Convener is most grateful to those who furnished such information.

2. REVIEW OF TUNA AND BILLFISH TAGGING IN THE ATLANTIC AND ADJACENT SEAS

2.1 Summary of tagging programmes

Information has been received on the following programmes, and the numbers of fish tagged and returns obtained by each are listed in Table 1.

Country	Agency	Source of Information
Canada	Fisheries Research Board FRB (Ca)	J.S. Beckett
Cuba	Instituto Cubano de Investigaciones Tecnológicas ICIT (Cu)	Suárez Caabro & Duarte Bello (1961)
	Centro de Investigaciones Pesqueras CIP (Cu)	A. Bosque Abreu
France	Institut Scientifique et Technique des Pêches Maritimes ISTPM (F)	H. Aloncle
	Office de la Recherche Scientifique et Technique d'Outre-Mer ORSTOM (F)	C. Champagnat A.C. Jones
Italy	Centro Sperimentale della Pesca CSP (I)*	R. Sara, P. Arena
	Società Informazioni Ricerche Ittiche Oceanografiche SIRIO (I)*	F. Schiavoni
Japan	Far Seas Fisheries Research Laboratory FSFRL (J)	S. Kikawa
	Kanagawa Prefectural Fisheries Experimental Station KPFES (J)	
Norway	Fiskeridirektoratets Havforsknings-institutt FH (N)	J. Hamre
Portugal	Instituto de Biología Marítima IBM (P)	H. Vilela
South Africa	Division of Fisheries DF (SA)	J.H. Stander
Spain	Instituto de Investigaciones Pesqueras IIP (SP)	J. Rodríguez-Roda
U.S.A.	Narragansett Sport Fisheries Marine Laboratory, National Marine Fisheries Service NSFML (U.S.A.)	J. Casey C. Stillwell
	Southeast Fishery Center, National Marine Fisheries Service NOAA, Department of Commerce MILAB (U.S.A.)	A.C. Jones
	Woods Hole Oceanographic Institution WHOI (U.S.A.)	F.J. Mather
U.S.S.R.	Atlantic Research Institute of Marine Fisheries and Oceanography AtlantNIRO (U.S.S.R.)	V. Chur

* Not included in Table 1 as no details available

The abbreviations shown in this list will be used in referring to the respective programmes in the text, tables and figure captions of this report.

The available data indicate that 45 542 tunas and billfishes have been marked in the Atlantic and 2 794 tags have been returned. Little information has been obtained on tagging in the Mediterranean, but some Atlantic tags have been recovered there. Significant numbers of returns have been obtained for bluefin tuna (2 334 from 12 718 releases), skipjack (90 from 4 096 releases), albacore (48 from 2 581 releases), white marlin (104 from 8 466 releases) and Atlantic sailfish (94 from 11 856 releases).

2.2 Bluefin tuna (Thunnus thynnus)

The most numerous and most important results of Atlantic tuna tagging have been from bluefin tuna. Although this species is very widely distributed, most of its fisheries exploit seasonal concentrations in relatively small areas. Also, the distributional patterns of the bluefin tuna, which is a long-lived fish (Sella, 1929), vary markedly with its age (Mather, 1962). Fish were tagged after capture by various methods from several of these concentrations. The releases and returns for the major tagging groups are accordingly listed by tagging area, season, size of fish, method of capture, and marking agency (Table 2).

2.2.1 Early tagging and studies based on hooks

The few marking experiments performed before 1954 did not produce significant results. Twenty taggings by Sella (1926) off southern Italy in 1911 and 107 by Frade and Dentinho (1935) off southern Portugal in 1931-35 yielded no returns. Westman and Neville (1942) obtained two returns - probably the first ever achieved for bluefin tuna - from 23 releases in the New York Bight in the summer of 1941. These fish were recaptured in the release area and within two months of the release date, however, and the programme was not continued. Other small-scale experiments off Long Island in 1940 and New Jersey in 1953 (unpublished data) were unsuccessful.

Several migrations and local movements of bluefin tuna were deduced from hooks or lures found in fish which had been caught by other means, but attempts to obtain more positive information by the use of marked hooks were unsuccessful. Sella (1926 a; 1927 a; 1929; 1930; 1932 a, b) (see also Heldt, 1929; 1930; 1931; 1932; 1937; 1938; 1943) collected hooks and lures which indicated several migrations between Atlantic and Mediterranean localities, as well as between different basins or regions in each of the bodies of water. Some doubts about these findings were expressed because the locality where the hooks or lures had been broken off could be determined only by the characteristics of the hook or lure, or of its attachment to the line or leader. Sella's results and these comments led to the use of the marked hooks (some marked with the locality and year of distribution only, and others marked with letters and serial numbers) as tuna tags. These were used off Brittany (Heldt, 1932), southern Portugal (Frade and Dentinho, 1935), in the North Sea (Russell, 1934), off the Bahamas, and off Long Island, New York (unpublished data). A marked hook recovered from a giant tuna which had been harpooned off Wedgeport, Nova Scotia "about 15 years ago", was returned during the summer of 1971, but the release data for it had not been reported.

2.2.2 Tagging 1954-1971

Sustained tuna tagging in the Atlantic was not justified until practical methods were devised. The first successful tuna tag was the dorsal loop tag developed by the California Department of Fish and Game (Wilson, P.C., 1953). This method was effective but could be used only for small fish which could be lifted from the water. Early tagging by WHOI (U.S.A.) and ISTPM (F) used this method. The development of the dart tag (Mather, 1962), the use of which did not require handling the fish or removing it from the water, made it possible to tag fish of the largest sizes, and also to tag smaller ones more rapidly. Tags of this general type have been used for all subsequent Atlantic tuna tagging.

2.2.2.1 Small bluefin tuna

Recaptures of small bluefin, which have been tagged in large numbers (Table 2), have shown seasonal returns to the respective release areas as well as some transatlantic migrations, and have suggested high exploitation rates in the western North Atlantic. In this area, 9 491 small bluefin have been marked by WHOI (U.S.A.) FRB (Ca), and NSFML (U.S.A.), and 2 244 returns (23.6% of the releases) have been obtained. ISTPM (F) and IEM (P) have marked 54 small bluefin in the Bay of Biscay and off the west coast of Portugal, and have secured four returns (7.4% of the releases). A few small bluefin have also been marked by CSP (I) in the Mediterranean.

The tagging in the northwestern Atlantic took place in summer and early fall on the Continental Shelf between Cape Hatteras, North Carolina, and Cape Ann (Gloucester), Massachusetts (Table 3) in the years 1954-1971. Most of the fish tagged were 50-105 cm long, with a few up to 135 cm. Of these fish, 7 664 were released from purse seine catches, resulting in 1 833 returns, and 1 827 were released from hook and line catches, mainly by sportsmen cooperating with WHOI (U.S.A.) producing 411 returns. In 1971, 575 small of these bluefin were double tagged from purse seine catches by WHOI (U.S.A.), FRB (Ca) and MILAB (U.S.A.) as part of a tag testing experiment recommended by the Sub-Committee on Stock Identification of ICCAT.

Most of the returns were from the release area and were recaptured in the general time of year in which they were released (July-September), but times at liberty ranged up to approximately four years. These returns showed that the same fish often returned seasonally to this area, sometimes up to four years after being tagged. They also showed a general tendency for the fish to move northward and eastward, from off Delaware Bay to off southern Massachusetts, as the season advanced. Some fish continued this movement around Cape Cod into Cape Cod and Massachusetts Bays, but others moved back to waters off New York Harbor late in the season. These tendencies varied from year to year, and also with size of fish. No returns have come from American waters north or east of Cape Cod since 1963, and the tendency to continue into those areas seemed stronger in the larger fish, whereas the movement back toward New York seemed more typical of the smaller ones.

The return rates for young bluefin tuna released in this area (Table 3) suggest that the stock is not large, and that it is being heavily fished. The seine fishery prior to 1962 was confined to one or two very small vessels fishing in Cape Cod and Massachusetts Bays. In 1962 and 1963, the fishery developed into an oceanic one with larger vessels, aided by air spotters, fishing from Virginia to northern Massachusetts (Wilson, P.C., 1965). Return rates for fish released in the years 1954-1962 ranged from 0 to 6.7% of each year's releases, with only two local recaptures before the 1962 season. Returns from fish released in the years 1963-1970 reached from 24 to 41% of each year's releases within 15 months, with the exception of the 1965 releases. Tag returns and catch statistics indicate that a considerable proportion of the fish tagged in that year migrated to the Bay of Biscay before the 1966 season. Second season (6-18 months at large) return rates are probably the most significant in estimating the fishing ratio, since fish recaptured in the season in which they were released may not constitute a representative sample of the stock. The second season return rate from the 1969 releases, nearly 25% greatly exceeded any previously obtained. The corresponding rate for the 1970 releases has already passed this figure before the processing of the catches has been completed.

These results suggest that, despite greatly reduced fishing effort compared with the 1963 and 1964 seasons (Table 4) the pressure on the stock is increasing. The Group of Experts on Tuna Stock Assessment (under the FAO Expert Panel for the Facilitation of Tuna Research), which met in Miami, Florida, 12-16 August 1968, concluded, after considering these and other data, that the "group of small bluefin fished off New England is certainly small and heavily exploited" and recommended that, pending better assessments, the landing of fish less than 10 kg in weight by the commercial fishery should be discouraged (FAO, 1968).

The tagging of small bluefin in the northwestern Atlantic also revealed occasional, but apparently significant, migrations from that area to the Bay of Biscay (Table 3) (Mather, 1960, 1969; Mather, Bartlett and Beckett, 1967). Forty of these west to east transatlantic migrations have been traced, all between the same two small areas (Figure 1) and all, as far as can be determined, having occurred between fishing seasons. All of the fish were released in July-August and recaptured in June-October of subsequent years, and had traversed distances of about 3 000 nautical miles. The fish were one or two years old (3.5-11 kg) (Mather and Schuck, 1960) when released, and all but three, which had been at liberty for four or five years, were two or three years old when recaptured. The tendency to migrate across the ocean appears to be strongest among the youngest of the small bluefin which were tagged in significant numbers in the northwestern Atlantic.

Fifty-four small (55-80 cm) bluefin were tagged from hook and line catches in the eastern Atlantic in the years 1968-1970, resulting in two local returns, and two from the northwestern Atlantic (Allain and Aloncle, 1968; Aloncle and Delaporte, 1970, 1971). The transatlantic migrants were released off the coasts of northern Spain (Bay of Biscay) and western Portugal in the Septembers of 1968 and 1969, and were recaptured off the northeast coast of the United States during the summer of 1970. These fish were one and two years old, when released; both were three years old when recaptured.

2.2.2.2 Large bluefin tuna

Since concentrations of large bluefin tuna occur over a much greater portion of the Atlantic Ocean than do those of small individuals, these fish have been tagged in more localities than the small ones. Important tagging areas in the western Atlantic have been the Straits of Florida, Nova Scotia, Newfoundland, and oceanic waters between the Gulf Stream and the Continental Shelf from Cape Hatteras to the Grand Banks of Newfoundland. In the eastern Atlantic, large bluefin have been tagged off the west coast of Norway and off the southern Atlantic coast of Spain.

The first sustained tagging of large bluefin occurred in the vicinity of the Bahamas, where 944 giant (over 200 cm) bluefin have been marked since 1953, mainly by sportsmen (fishing with rod and reel), cooperating with WHOI (U.S.A.),and nine of these (1% of the releases) have been recaptured in three distant and widely separated areas (Table 2, Figure 1) (Mather, 1962 a, 1963 a, 1969).

Although it had generally been assumed that the schools of giant bluefin which pass northward along the northwest edge of the great Bahama Bank in May and June are the same ones which appear off New England, Nova Scotia and Newfoundland during the summer (Rivas, 1955), the first five returns from the tagging off the Bahamas, as well as a subsequent one, were from Norwegian waters (Figure 1). All of these fish were released near Cat Cay (northwestern Bahamas) in May or June, and recaptured from early August to early October. One of the tagged fish made the voyage of over 4 200 nautical miles in 50 days and three others were recaptured after from 82 to 119 days at large. These tuna must have crossed the Atlantic during the warm season. Each of the other two fish tagged off the Bahamas and recaptured off Norway had been at liberty for about 26.5 months. The grouping of these migrations by years and estimates, based on studies of body condition, of the annual recruitment of western Atlantic bluefin tuna into the German North Sea fishery (Tiews, 1964) are in reasonable agreement and suggest that this recruitment is important in some years but undiscernible in others.

The only known transequatorial migration of a bluefin tuna was made by an individual released off the northwestern Bahamas in May 1963, and recaptured off Recife, Brazil in March, 1965. This fish weighed approximately 170 kg when recaptured. The Japanese long-line fishery for large bluefin tuna often centers in the latter area in March and April, then moves northwestward to off the Bahamas in May and northward to off the Carolinas in June (annual reports of the Fishery Agency of Japan). This tag return suggests that this fishery may indeed be exploiting the same stock throughout this period.

The other two returns from releases off the northwestern Bahamas were from oceanic waters outside the edge of the continental shelf off northeastern North America. One was released in May 1966 and recaptured 140 miles southeast of Nantucket Island, Massachusetts, in June 1970. The other was released in June 1970, and recaptured 30 days later 100 miles southeast of Sable Island, Nova Scotia. These are the only returns which might support the hypothesis of a migration from the Bahamas to the northeastern coasts of North America, but the fish could also have been enroute to Norway.

FRB (Ca) has marked 398 large (over 200 cm) bluefin tuna from summertime trap catches in St. Margarets Bay (near Halifax), Nova Scotia, since 1962, and 13 of these tags (3.3% of the releases) have been returned (Figure 2)(Beckett, 1970). All recaptured fish were from 225 to 260 cm long. Nine of the returns were local, eight in the release season and one in the following summer. The other four traced fairly long migrations, one to the area off Wedgeport, Nova Scotia, and three to the vicinity of Cape Cod. The fish recaptured off Wedgeport (in September) had been at liberty for only 49 days, but two of those recaptured off Cape Cod (in August) had been at liberty for about one year, and the other (recaptured in June)for about two years. These returns suggest that the large bluefin which occur off New England and those which occur off Nova Scotia mix freely in the whole area.

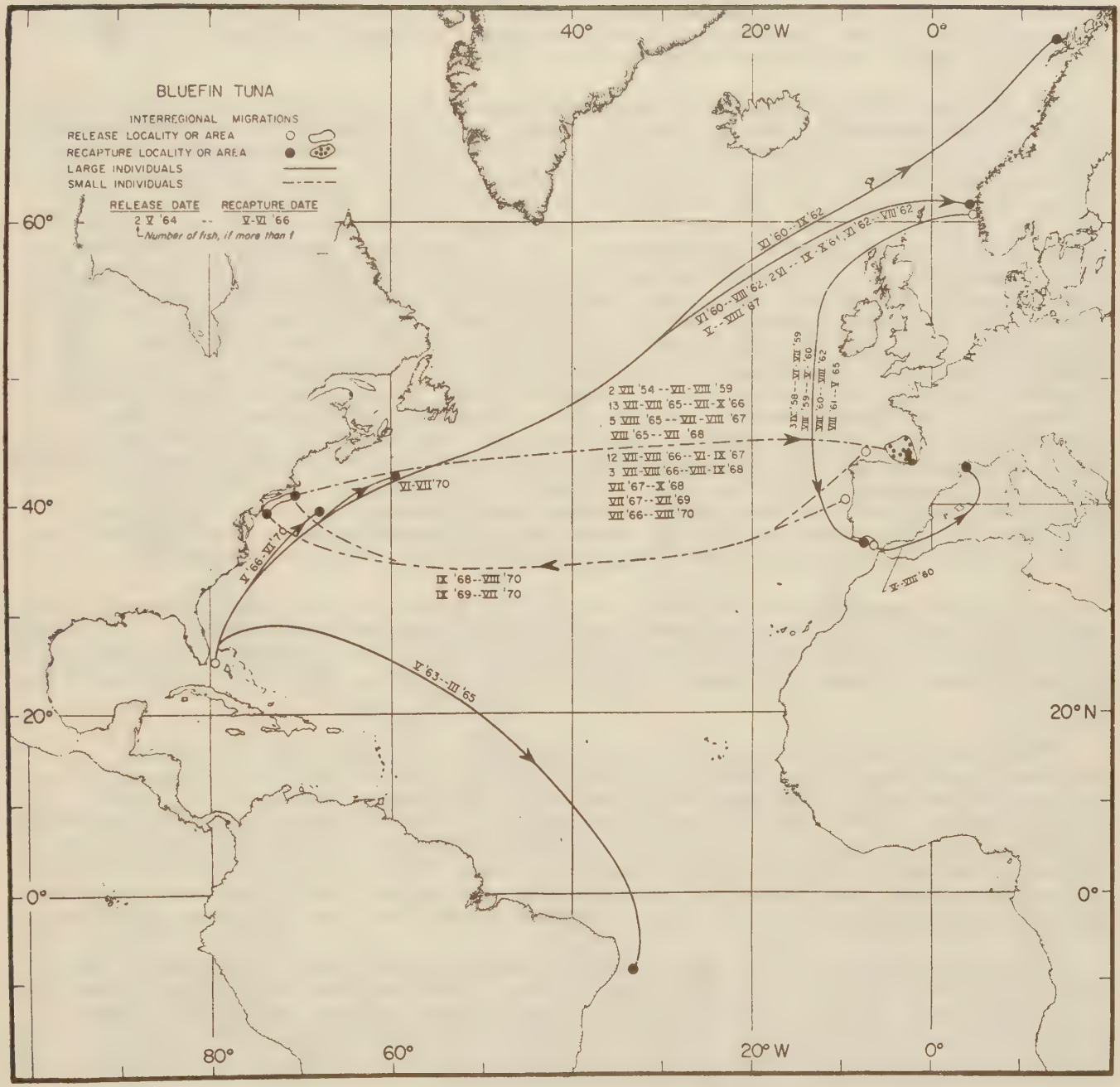

Figure 1. Interregional migrations of bluefin tuna.

Sport (rod and reel) fishermen cooperating with WHOI (U.S.A.) and FRB (Ca) (Beckett, 1970) have marked 738 giant bluefin tuna during the summer fishing seasons along the east coast of Newfoundland, and three of these tags (0.3% of the releases) have been returned (Table 2), all from this same area. Two of the fish had been at liberty less than a month when recaptured, but one of these had travelled about 225 nautical miles from Notre Dame Bay to the head of Trinity Bay. The release-return localities for the third recaptured fish were the same as for the one last mentioned, but the present individual had been at liberty for almost three years, from September 1968 to July 1971.

WHOI (U.S.A.), FRB (Ca), and NSFML (U.S.A.) have released 491 bluefin tuna from longline catches (March-November) in oceanic waters between the Gulf Stream and the continental shelf from Cape Hatteras to the Newfoundland Banks in 1957-68, and nine returns (1.8% of the releases) have resulted (Table 2, Figure 2) (Anonymous, 1964; Beckett, 1970; Mather, 1960; Mather and Bartlett, 1962). The tagged fish ranged from 70 to 250 cm, with the majority from 115 to 200 cm. Seven of these fish were recaptured on the continental shelf between southern Maryland and northern Massachusetts. Six of these were recaptured in the same fishing season in which they were released. The other was recaptured in the next fishing season (about a year later), following a similar date and locality pattern. These data indicate that the fish approached the U.S. Middle Atlantic coast in late spring from the east, rather than from the south as had been generally supposed. During the summer, the apparent movement of these fish in the coastal waters was northeastward, like that of the larger of the small bluefin tagged in the inshore fishery during the same season. A bluefin tagged in the Eastern Channel, near the Nova Scotia Banks in November, 1960, was recaptured at Veatch Canyon, south of Nantucket Island, in June 1963, and one tagged at Atlantis Canyon, in the same vicinity, in November, 1960, was recaptured off Cape St. Mary's, Nova Scotia in August, 1968. The time at liberty of 93 months for the latter is the longest yet recorded for a tuna tagged in the western Atlantic. These two migrations strengthen the indications given by the three from St. Margaret's Bay to Cape Cod that the larger bluefin tuna which occur off New England and Nova Scotia constitute a single stock.

FH (N) has tagged 242 large (150-250 cm) bluefin tuna from purse seine catches off the west coast of Norway in August-September 1957-62 with Norwegian Lea tags (Akyüz, 1970, p. 43). They obtained 26 returns from Scandinavian waters and 6 from off the southern Atlantic coast of Spain (Table 2, Figure 1) (Hamre, 1959, 1960, 1961 a, 1962 a, 1963, 1965; Rodríguez-Roda, 1959).

The local recoveries confirmed migratory patterns in Norwegian waters which had previously been deduced from studies of size frequencies (Hamre, 1962): the tunas reach the coast at about 62°N latitude, whence the larger individuals, which arrive in July, migrate northward and the smaller ones, which arrive in August-September, migrate southward. One tag return also confirmed the previously deduced hypothesis that the fish change from the latter pattern to the former at the age of 12 years. Nine of the local returns were in the release season, nine were after about one year at liberty, three after about two years, and single tagged fish had been at large for about three, five, six, seven and eight years.

Six bluefin tunas marked in the vicinity of Bergen, Norway, were recaptured in the vicinity of Cadiz, Spain, in the period May-August. These included individuals released in each of the years 1958-61. The frequency of these returns suggests that this may be a regular migratory pattern. The fisheries in spring and early summer in the Atlantic approaches to the Mediterranean and those off Norway and in the North Sea in late summer and early fall, probably depend in part on the same stock.

The overall return rate of 13.2% for the Norwegian taggings is the highest known for large bluefin tuna. Also, the time at liberty of 96 months for one of the local recoveries is the longest ever recorded for a tagged tuna. The Lea tag has an interesting advantage, in that it gives some indication of the maximum depths at which tagged and recaptured fish have travelled. Pressure marks, which were absent from tags recovered off Norway in the season during which the fish were tagged, were found on all those recovered more than eight months after release. Hamre (1964), after experiments to determine the pressure required to

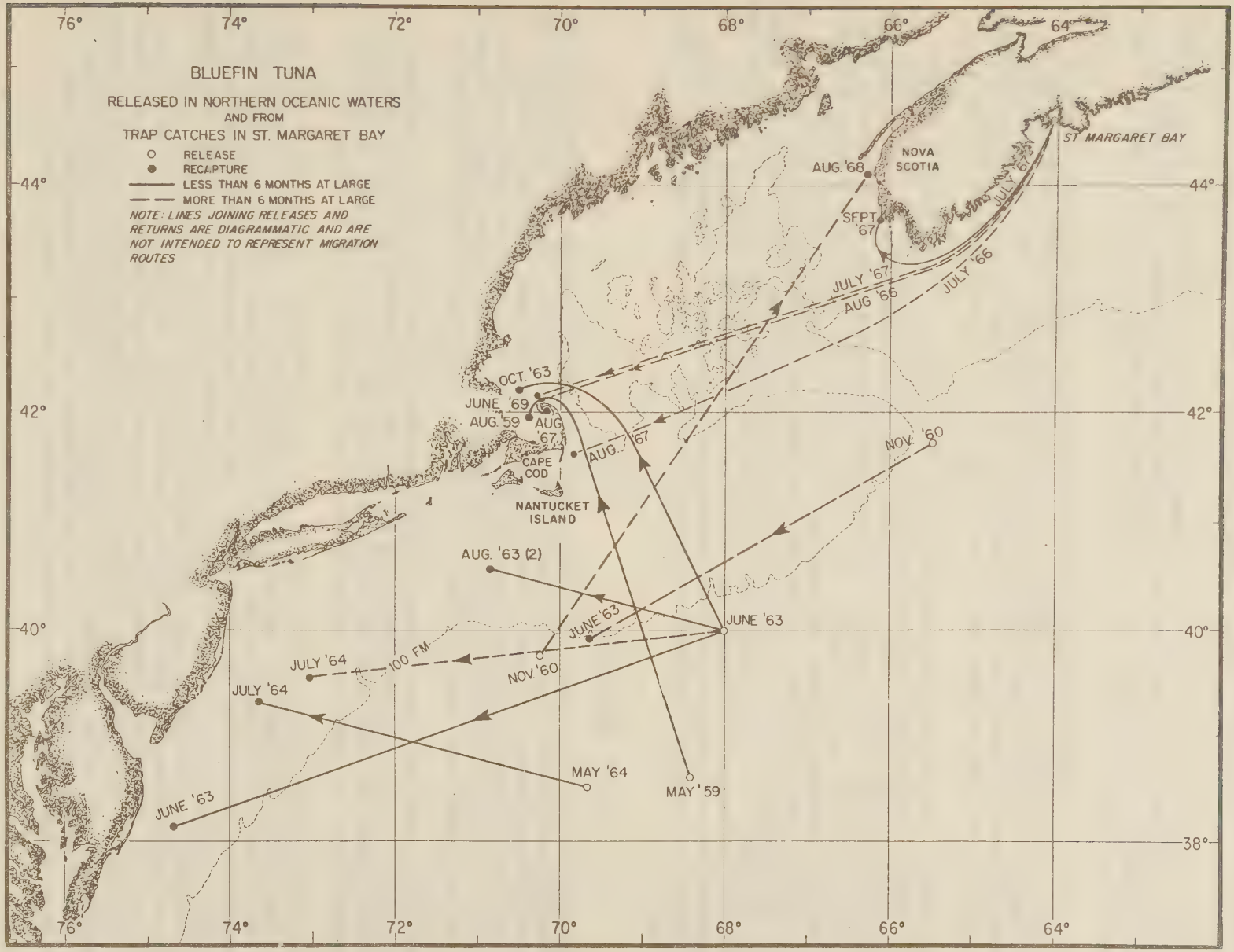

Figure 2. Recaptures of bluefin tuna tagged by FRB (Ca) from trap catches (after Beckett, 1970) and by WHOI (USA) from offshore longline catches.

produce these marks, concluded that the bluefin tuna stock feeding off the Norwegian west coast during the summer probably does not go below a depth of 250 m, whereas the stock seems to have a deeper distributional range during the winter.

IIP (SP) has marked 312 bluefin tuna, 60–220 cm from traps near Cadiz, Spain, in May–August. Four of these tags have been returned from the Mediterranean, and 15 from the Atlantic coasts of southern Spain, southern Portugal, and Morocco (Table 2, Figures 1 and 3) (Rodríguez–Roda, 1960 a, 1963 a, 1964 a, 1966 a, 1969 a, b, 1970, 1971).

Only one of the Atlantic recaptures from these experiments occurred far from the release area. This individual was marked in August 1962 and recaptured (weighing 175 kg) between Mogador and Agadir, Morocco, in December of the same year. The other Atlantic recaptures occurred in May–August, after periods of from one day to 22.5 months at liberty. When recaptured, the fish weighed from 44 to 270 kg with only one exceeding 175 kg.

The returns from the Mediterranean are of great interest, in view of the unsolved question whether Atlantic and Mediterranean bluefin mingled or not (Heldt, 1929, 1930, 1931, 1932, 1934, 1937, 1938; Sella, 1929). Although two of the recoveries were just within the Mediterranean, at La Línea and Ceuta on the Straits of Gibraltar, the other two were from points well within that sea, Cartagena, Spain, and Palavas (Gulf of Lion), France (Figure 3). In addition, a fisherman reported the recapture in 1967 of two bluefin tuna bearing Spanish tags in a trap at Tripoli, Libya, but the tags, most unfortunately, were not returned. Three of the recaptured fish were released in May or June, and the other in August. These fish weighed from 41 to 120 kg when recaptured, and had been at liberty for periods of from 19 to 85 days. These returns proved that some tuna migrate from the Atlantic into the Mediterranean, but more tagging, in the Mediterranean as well as in the eastern Atlantic, is required to determine the geographical extent, numerical volume, and regularity of these migrations.

2.2.2.3 Discussion

Althouth most of the important Atlantic bluefin tuna fisheries are concentrated in a few relatively small areas adjacent to land masses or shoal areas, tag returns have revealed migrations between several of these fishing grounds, including some which are widely separated. Some of these migrations appear to fit with annually repeated patterns, but others do not. They are of interest from the viewpoints of stock identification, interaction between stocks, and learning which fisheries are affecting the respective stocks.

The most numerous of these recorded migrations were between the only two important fishing grounds for young bluefin tuna (2.5–50 kg), the northwestern Atlantic bight (between New Jersey and Cape Cod) and the Bay of Biscay and the nearby coast of Portugal. Forty west–east and two east–west migrations have been recorded by tag returns.

Some small bluefin tuna have been tagged in the northwestern Atlantic bight in each summer after 1953, but only fish released in 1954, 1965, 1966 and 1967 have been recaptured in the Bay of Biscay. The only periods in which tag returns have proved definitely that these migrations occurred are 1965–66, 1966–67, 1967–68, and sometime between 1954 and 1959. Comparison of recaptures in the Bay of Biscay with corresponding ones (by years of release and of recapture) in the release area indicate that these migrations are made by only fractions of the northwestern Atlantic stock – perhaps 1/50 of the stock in 1966–67 and 1967–68, and 1/5 in 1965–66 (assuming that the probabilities of tag recovery and return are the same in the two areas). The importance of the 1965–66 migration is also suggested by a notable increase in the landings of bluefin tuna at St. Jean de Luz, the chief port for the French bluefin tuna fishery of the Bay of Biscay, and a correspondingly sharp decline in the landings of the northwestern Atlantic purse seine fishery (Table 4).

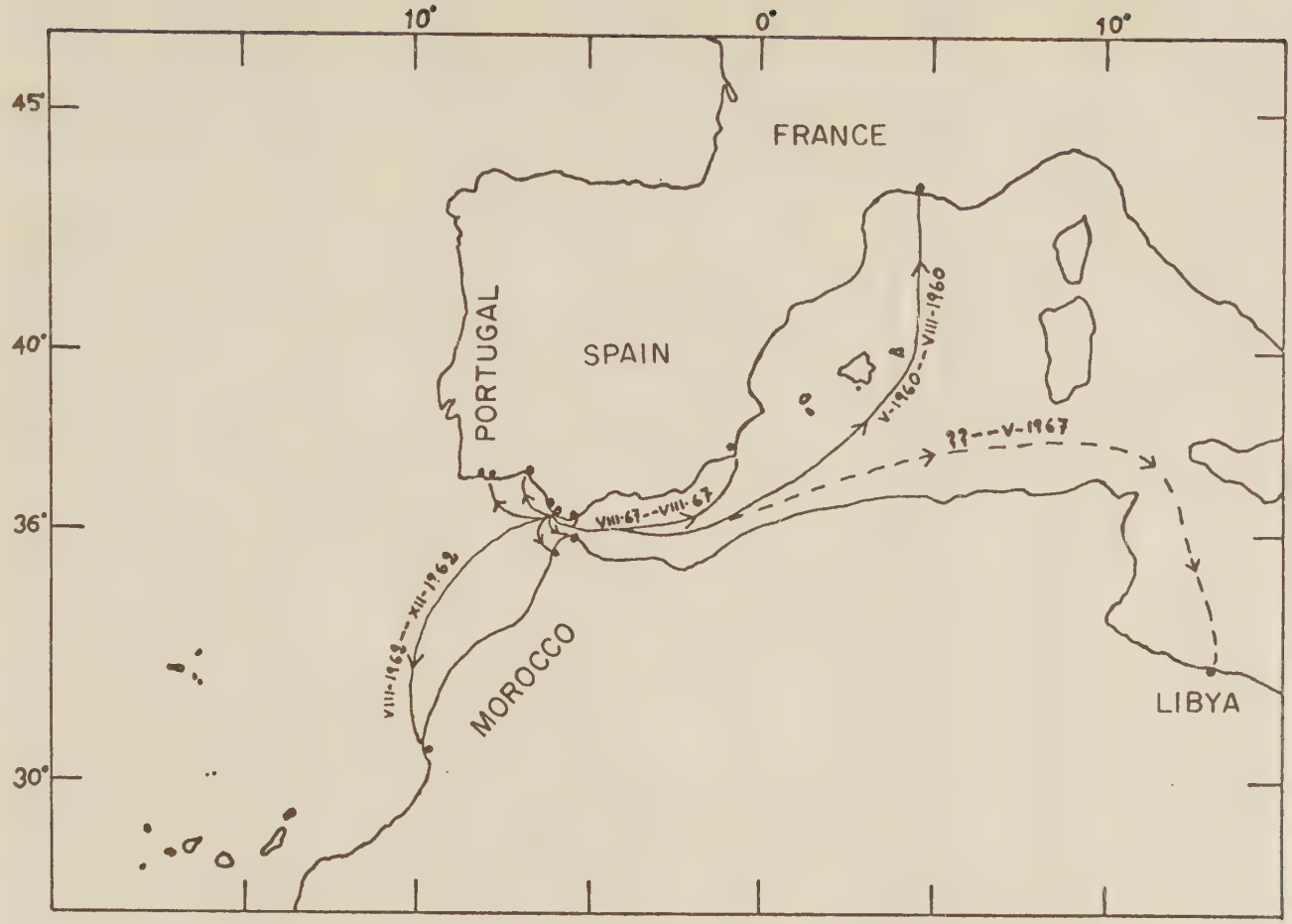

Figure 3. Recaptures of bluefin tuna tagged by IIP(S) from trap catches off the southern Atlantic coast of Spain, after Rodriguez-Roda, (1969a). The recaptures off Libya were reported, but the tags were not returned.

The two recorded east-west transatlantic migrations occurred between the 1968 and 1970 and the 1969 and 1970 seasons, respectively, making it certain only that one took place in the period 1969-70. Only two of the tags released in the eastern Atlantic were recovered locally, each in its release season (1968 and 1969). Thus no comparison between the numbers of corresponding local and transatlantic recoveries is possible, but the decline of the St. Jean de Luz landings in 1968 and 1969, and the increase in the northwestern Atlantic landings in 1969 and 1970 (Table 4), again suggest that this transatlantic migration might have affected the landings in the two areas.

This meagre evidence indicates that these migrations are non-cyclical and represent a splitting of the respective stocks, which varies in magnitude from year to year and possibly does not occur at all in some years. Comparison of tag returns from the two areas suggests that the fraction of the northwestern Atlantic stock making this migration is small. From variations in the annual catches in the respective areas coinciding with the maximum west-east migration indicated by tagging (1965-66) it appears, however, that these migrations may be more important than this comparison of tag returns indicates. This apparent discrepancy may be due to poorer chances of tag recovery and return in the Bay of Biscay than in the northwestern Atlantic, as suggested by the relatively low return rate, 3.7% from local releases in the former area.

Since the Bay of Biscay and the northwestern Atlantic bight are the only important fishing grounds for young bluefin tuna (2.5-50 kg) in the Atlantic, and several of the fisheries based on older bluefin are defunct or declining, it is most important to obtain more definite information on the interaction between these stocks through larger and more sustained programmes of tagging, size sampling, and collecting of catch and effort data in the respective areas.

There is less information on the more extensive and complex inter-relationships between the stocks or groups of larger bluefin tuna in the Atlantic. Fish tagged off the northwestern Bahamas have been recaptured off the New England and Nova Scotian banks, off the coast of Norway, and off the easternmost part of Brazil. Others marked off Norway have been recaptured off the southern Atlantic coast of Spain. Individuals tagged in the latter area have been recaptured within the Mediterranean Sea. These facts suggest that these movements may be part of a large migration pattern, but there were differences in the sizes of the fish for which the migrations were recorded. The tagged fish which migrated from the Bahamas to Norway weighed from 211 to 285 kg when recaptured. Those which migrated from Norway to the southern coast of Spain weighed 138-217 kg, with only one exceeding 176 kg. Those which migrated from the latter area into the Mediterranean weighed only 41-120 kg. These differences suggest migrations by different age components, rather than by a homogeneous stock. There were also indications that the Bahamas-Norway migrations were irregular rather than cyclical. Data from recaptured fish suggested that giant bluefin tuna arriving in northwestern European waters from the western Atlantic could be distinguished from the resident stock by their lean body condition. Tiews (1964), using body condition data for German North Sea bluefin catches for the years 1952-62, estimated that recruitment from the western Atlantic contributed as much as 39% of the catch in some years, but gave no discernible amount in others. One of the periods of maximum estimated recruitment, 1960-62, corresponds with the years in which four of the six transatlantic migrations of tagged giant tuna were probably made. The fat body condition of the two bluefin which had been tagged in the Bahamas and recaptured off Norway about 26.5 months later indicated that they had crossed the ocean in a previous season, and had spent their last summer feeding in Norwegian waters. Giant bluefin were tagged off the Bahamas in nearly all of the years 1954-71, but the only recorded migrations to Norway were in 1960-62, 1961, 1962 and 1967. On the other hand, migrations from Norway to the south Atlantic coast of Spain were recorded for each year in which adequate numbers of fish were marked with effective tags, and appear to be regular annual occurrences.

Migrations from the eastern Atlantic into the Mediterranean have been traced, but more tagging in both areas is required to determine the regularity, geographical extent and numerical volume of these migrations, as well as of possible ones in the opposite direction.

More tagging off the Bahamas is also needed to determine whether the giant bluefin which migrate through the Straits of Florida are actually the same ones which occur in summer off northeastern North America. The chances of settling this question would be improved, and other important information might be gained, by also tagging the very small (1-3 kg) bluefin which sometimes pass northward through the Straits of Florida in summer.

Tagging in the South Atlantic off eastern Brazil is also needed to further establish the relationship of the large bluefin stock which occurs there in March and April with the various concentrations in the North Atlantic.

So far, the tagging of large bluefin may well have raised more questions of population identity than it has answered. Only more sustained and active tagging programmes can provide the answers.

2.3 Albacore (Thunnus alalunga)

To date, 2 581 albacore have been tagged in the Atlantic, and 48 returns have resulted (Table 5). There have been no returns from over 200 releases of large individuals from longline catches, but the return rate of 2% from smaller (50-80 cm) fish marked from trolling catches in the eastern North Atlantic (May-September) by ISTPM (F) is encouraging (Letaconnoux, 1963, 1971; Allain, 1967; Allain and Aloncle, 1968; Aloncle and Delaporte, 1970, 1971). Tags recovered in the same season (from releases east of 14°W) indicated a seasonal migration route northward along the west coast of Portugal to waters southwest of Ireland, then toward the edge of the continental shelf and well into the Bay of Biscay (late September / early October), and finally to the westward along the Cantabrican coast. Sixteen other recoveries showed that albacore returned to these fishing grounds after one or two years of liberty, and the dates and localities of most of these recaptures also fitted this pattern (Aloncle and Delaporte, 1971 a).

2.4 Yellowfin tuna (Thunnus albacares)

Results for yellowfin tuna have been modest to date, with 929 releases and four returns through 1970, but the large 1971 effort of ORSTOM (F), tagging 1 648 fish in the Gulf of Guinea with the cooperation of MILAB (U.S.A.) should improve the situation (Table 6). Four local recaptures from this effort of fish, which had been at liberty for from 5 to 61 days, have already been reported. Three local returns had previously been recorded from the 1967 releases of FRB (Ca) in the Gulf of Guinea, all after less than 18 months at liberty (Beckett, 1970). There have been no returns from over 500 yellowfin tagged from longline catches. Sustained tagging in the surface fisheries in the Gulf of Guinea appears to offer the best chance of obtaining significant results for this important species.

2.5 Blackfin tuna (Thunnus atlanticus)

The only successful tagging of blackfin tuna was carried out by ICIT (Cu) in April-October 1959. One thousand four hundred and fifty-eight blackfin tuna were released, along with 541 skipjacks and, as of 30 October 1960, 92 fishes of both species had been recaptured (Suárez Caabro and Duarte Bello, 1961). All the releases were in localities along the north and south coasts of western Cuba. The returns showed numerous movements between these localities, but none to outside the general release area. This may have been due to the absence of commercial fishing for the species in other areas. This condition may also account for the lack of returns, excepting one which had been at liberty for only a few days, from over 500 other releases (Table 1) in the western North Atlantic (south of Cape Hatteras). A new tuna tagging programme in Cuba (Agger, 1970) may yield more information on this species.

2.6 Bigeye tuna (Thunnus obesus)

There have been no returns from 231 releases of bigeye tuna in various parts of the Atlantic (Table 1). All of these were from longline catches. As with yellowfin tuna, the best possibility of obtaining significant results for this species would probably be from tagging in the surface fisheries in the Gulf of Guinea.

2.7 Skipjack (Katsuwonus pelamis)

Despite over 4 000 releases and over 90 returns (Table 7) (Allain and Aloncle, 1968; Aloncle and Delaporte, 1970; Beckett, 1970; Mather, 1965; Suárez Caabro and Duarte Bello, 1961), tagging has revealed little about the migrations and populations of skipjack. The only taggings which have produced significant numbers of returns were those of ICIT (Cu) off western Cuba, and of FRB (Ca) and WHOI (U.S.A.) in the northwestern Atlantic. ICIT (Cu) released 541 skipjack along with 1 458 blackfin tuna, and by end October 1960, 92 fishes of both species had been recaptured (Suárez Caabro and Duarte Bello, 1961). All the releases were in localities along the north and south coasts of Cuba. The returns showed numerous movements between these localities, but none to outside the general release area. FRB (Ca) and WHOI (U.S.A.) released 1 989 skipjack from purse seine catches between Cape Hatteras, North Carolina, and Cape Cod, Massachusetts, in the summers of 1964-1966 (Beckett, 1970; Mather, 1965). Seventy-four tags from the 761 fish released in 1964 were returned in that same season for a return rate of nearly 10%. This was the season of maximum fishing effort in this fishery, and considerable numbers of releases in 1965 (445 fish) and 1966 (783 fish) yielded only about 1% return. Only two tags were returned after over six months at liberty, and each was recovered in the summer subsequent to that of its release. This indicates that most of the skipjack pass through this fishery only once. This is also suggested by a size sampling programme which showed a dominant mode at about 53 cm in each season, with little representation of other age groups. As with the ICIT (Cu) releases, none of the fish marked in the Cape Hatteras-Cape Cod area were recaptured elsewhere. This may be a result of the paucity of intensive fisheries for this species in the western North Atlantic. Results of the 1971 taggings of 794 skipjack by ORSTOM (F) and MILAB (U.S.A.) from live-bait catches in the Gulf of Guinea and the new Cuban programme (Agger, 1970) should give good indications of the possibilities of tagging this species.

2.8 Broadbill swordfish (Xiphias gladius)

Two hundred and sixty-four broadbill swordfish have been tagged by FRB (Ca), NSFML (U.S.A.) and WHOI (U.S.A.) all in the northwestern Atlantic (Cape Hatteras-Grand Banks) in the years 1961-71, and fifteen returns have resulted (Table 8) (Beckett, 1970). Although half of these fish were at liberty for periods of between 6 and 54 months, not one was recovered far from the release point. Since most of the fish were tagged and also recaptured during the warm season, however, these results do not necessarily prove that the species is non-migratory. The return rate for fish tagged by harpoon when swimming free (Beckett, 1968) (17.5%) is much greater than that for fish tagged from longline catches (2.0%). Thus, it would appear that, wherever it is feasible, swordfish should be tagged when swimming free rather than after being caught by hook and line.

2.9 White marlin (Tetrapturus albidus)

Over 8 400 white marlin have been released in the western North Atlantic by sport fishermen cooperating with WHOI (U.S.A.) in the years 1954-71 and 103 returns have been obtained (Table 9) (Mather, 1960, 1963 a, 1965 a, 1967 a, 1969; Mather, Jones and Beardsley, in press). All of the returns were in the North Atlantic, and west of longitue 35° W (Figure 4).

Nearly 7 000 of the releases were in summer on the continental shelf between Cape Hatteras and Cape Cod, and 89 of the returns were from these releases. These returns reveal a fairly distinct migratory pattern for this aggregation of white marlin. At the end of summer, the fish move eastward from the coast toward mid-ocean, then go southward to a wintering area off the northern coast of South America, where most of the recaptures occurred between mid-October and mid-February. In spring these fish return northward through or along the West Indies and the Bahamas, with many passing through the Yucatan Channel and the Straits of Florida. Their return to the release area is indicated by recaptures in spring, east of the United States and north of the Bahamas, and numerous recoveries in the release area in subsequent summers after periods of approximately one, two, three and four years at liberty. Times at liberty (Table 10) are long, and indicate a survival rate of approximately 70% per year for fish tagged between Cape Hatteras and Cape Cod and subsequently recaptured (Mather, Jones and Beardsley, in press).

Less has been learned about concentrations of white marlin which occur in summer and early fall in the northern Gulf of Mexico and off Venezuela. These are evidently not composed of the same fish as the one found between Cape Hatteras and Cape Cod in summer. Over 1 450 white marlin have been tagged in southern waters (south of latitude 35°N), and 14 of these tags have been returned (Table 9, Figure 4). Two of these fish, tagged in March off the Bahamas and off Venezuela in October and both recaptured in June north of the Bahamas, were evidently following the pattern described for white marlin tagged between Cape Hatteras and Cape Cod. Other returns suggest an interchange between the Gulf of Mexico in summer and the Straits of Florida in winter, and an eastward movement along the north coast of South America between August-September and November-December. More tagging is needed to identify the stocks in southern waters and to define their migratory patterns. This problem is further complicated by occurrences of white marlin from the Cape Hatteras-Cape Cod summering area off the north coast of South America in late fall and winter, and in the Straits of Florida and the vicinity of the West Indies and Bahamas in spring.

The migrations of the white marlin extend well out into the ocean, and the majority of the recaptures of this species have been by longline fisheries.

2.10 Blue marlin (Makaira nigricans)

Sport fishermen cooperating with WHOI (U.S.A.) have marked 672 blue marlin in the northwest Atlantic in the years 1955-71, and five of these have been recaptured (Table 1) (Mather, Jones and Beardsley, in press). Three of the recaptures were near the release points (Venezuela, Bahamas and central Gulf of Mexico), after periods of from 4 to 26 months at liberty. One of the others was released off Chub Cay, Bahamas, in February 1969, and recaptured in the central Gulf of Mexico in August, 1971. This fish had grown from an estimated 90 kg (live weight) when released to 163 kg (eviscerated) when recaptured 30 months later. The serial number on the fifth tag, which was recovered from a 75 kg blue marlin off Cape Hatteras, North Carolina, in August, 1970, had been obliterated. The only releases of small blue marlin with this type of tag previous to this recapture had occurred in 1969, off the Virgin Islands (6), off the northwestern Bahamas (7), or Fort Lauderdale, Florida (1). Unless the release of this fish was not reported, it must have occurred in one of these localities in 1969. Since the blue marlin stocks in the Atlantic have evidently been seriously affected by longline fishing (Hayasi et al., 1970), it is important to mark this species in greater numbers. It seems most practical to mark the smaller (less than 100 kg) individuals.

2.11 Sailfish (Istiophorus albicans)

Nearly 12 000 sailfish have been tagged in the western North Atlantic by sport fishermen cooperating with WHOI (U.S.A.) and 94 of these have been recaptured (Table 11) (Mather, 1960, 1961, 1962 a, 1963 a, 1964, 1965, 1969). Most of the releases and all of the recaptures were between the Equator and latitude 35°N, and west of longitude 55°W. The majority of the returns were near the release point, or showed local movements along the southeast coast of Florida where most of the tagging was done. Several, however, showed longer migrations (Figure 5). These do not show a clear-cut pattern, but some seasonal

Figure 4. Recaptures of white marlin by assumed summering areas, and areas and seasons of release. Arrows indicate migratory tendencies suggested by tag returns, according to assumed summering areas of fish (see legend).

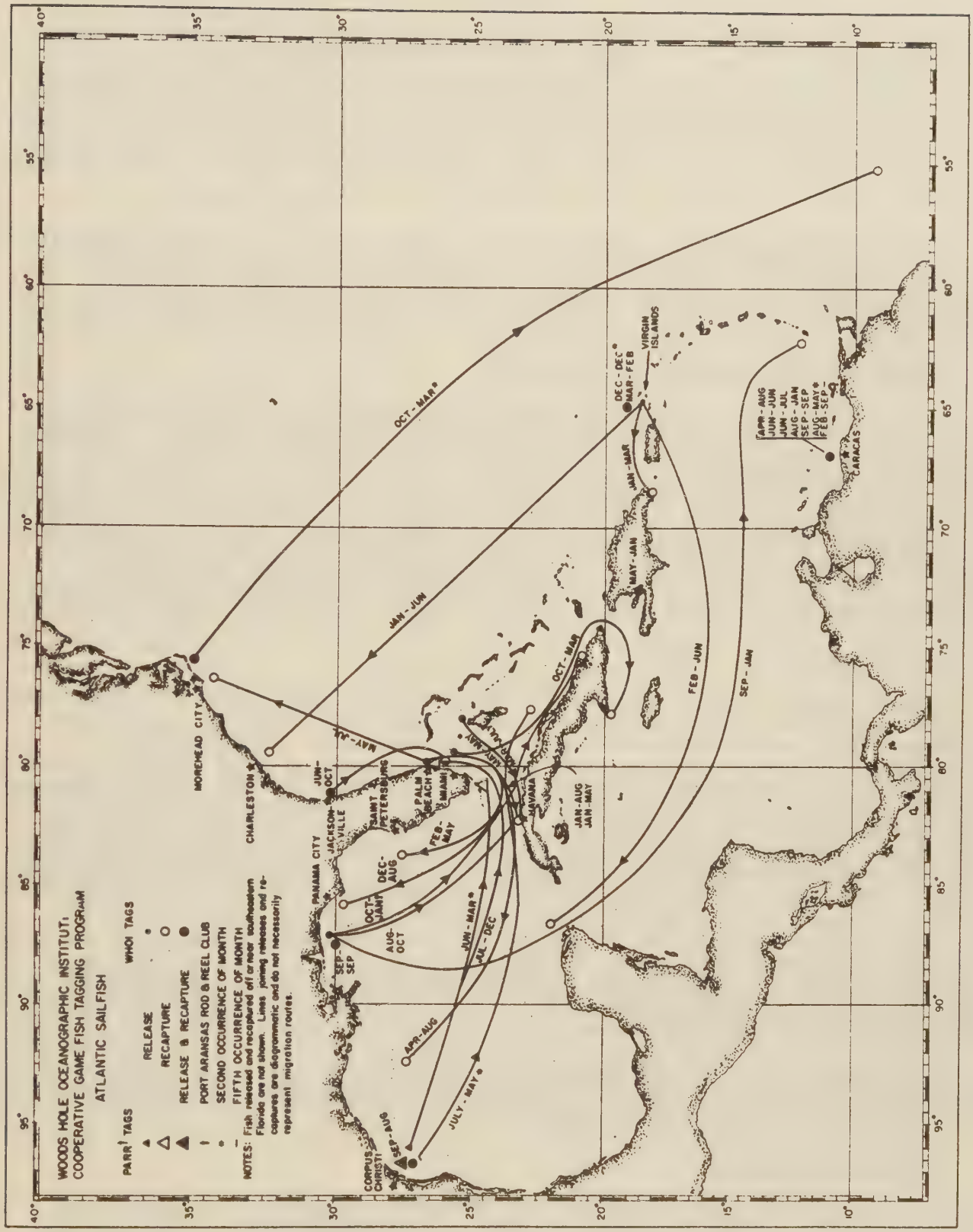

Figure 5. Longer migrations of sailfish shown by tag returns.

migratory tendencies are suggested. Fish tagged in the Gulf of Mexico during the warm season have been recaptured in the Straits of Florida and off the West Indies during the cold season. Fish tagged in the Straits of Florida and off the Virgin Islands in winter have been recaptured in the Gulf of Mexico and also off the Carolinas during the warm season. Single returns have shown southward migrations from off Jacksonville, Florida in June and off Cape Hatteras, North Carolina in October to southeastern Florida in October and the northeastern coast of South America off Surinam in March, respectively. Thus there appears to be a tendency for sailfish to expand their range into temperate regions during the warm season, and to return to tropical waters during the cold season. Tag returns also suggest that there is a resident stock of sailfish off the coast of Venezuela.

Times at liberty for sailfish have been short, with very few tags having been recovered more than 18 months after their release. This is in accord with growth studies (De Sylva, 1957) which indicate that the species grows rapidly and is short lived. Judging by results of tagging in the western North Atlantic, the sailfish is less oceanic in its distribution than the white marlin, and less subject to capture by longline fisheries.

3. DISCUSSION, RECOMMENDATIONS AND CONCLUSIONS

Considerable progress has been made, through opportunistic tagging with a variety of tags, in developing tags and tagging techniques and even in obtaining important information on the migrations and populations of some species. The time has come for more careful design of tagging experiments to determine the best types of tags, tagging techniques, and methods of capture for tagging for each size and species of fish in a given area. Experiments should also be planned to provide estimates of shedding rates and tagging mortality. Priorities should be determined so that major tagging efforts should be concentrated on key stock components to solve important problems of migratory patterns, population structure, and fishing mortality. Much progress was made in these areas at the meeting of the ICCAT Sub-Committee on Stock Identification at Lisbon in April, 1971 (ICCAT, 1971).

3.1 Tag types

There had been no planned experiments to compare types of tags before 1971. Two types of tags have been used extensively in marking small tunas in the Atlantic: the Floy FT-1 type (Akyüz, 1970, p. 79) with a small moulded plastic dart, which is similar to the standard IATTC tag, and various tags with stainless steel darts, of which the WHOI type "H" tag (Akyüz, 1970, p. 85) has been used in the greatest numbers. The type "H" tag apparently has greater retentive power than the FT-1, and is also more rugged and trouble free, especially when used for tagging fish in the water. There has been no evidence that the larger dart of the type "H" tag causes higher tagging mortality in even the smallest tunas (3 kg) single tagged in significant numbers, but little double tagging of small fish, using two tags of this type, has been done. The tag comparison now being carried out in the northwestern Atlantic by FRB (Ca), NMFS (U.S.A.) and WHOI (U.S.A.) should determine which type of tag is best for double tagging fish of various sizes from purse seine catches. An effort is being made to single tag small bluefin caught by hook and line concurrently, alternating the two types of tags. This experiment should quickly establish the relative mortality plus shedding and relative shedding rates of the two types of tags, and, if continued, should permit estimates of true shedding rates.

Various types of tags have been used to mark large bluefin in the eastern Atlantic. The Norwegian Lea tag (Akyüz, 1970, p. 43) has yielded higher return rates and has been held for longer periods than the other tags used.

3.2 Tagging techniques

Tagging techniques vary considerably with the method of capture for tagging. Fish caught by bait boat are tagged on board the vessel. A short applicator is used, and the fish are often held in a cradle while being tagged. Small fish caught by purse seine are taken from the water with a large dip net and marked in the seine skiff, usually in a

cradle or on a pad. Short applicators are also used in this procedure. Small fish caught on hook and line can be marked in the same manner. Large fish caught in purse seines or traps are usually tagged while they are being drawn over the edge of the net, often in a trough-like device. Large fish caught by hook and line are usually marked alongside the vessel, without removing them from the water. The applicator is mounted on the end of a pole or suitable length for the operating conditions. Large fish are also tagged while swimming free, by harpooning tags into them.

3.3 Tagging mortality

Tagging mortality has not been estimated quantitatively, but return rates indicate that it varies considerably with the method of capture for tagging. Experience in the Pacific indicates that tagging from bait boat catches generally yields higher return rates than tagging from purse seine catches, unless special precautions are taken in the latter operation. In the northwestern Atlantic, return rates for small bluefin tuna tagged from sport trolling catches have usually been higher than those for similar fish tagged from purse seine catches. The uniformly high return rates obtained by nearly all cooperating sportsmen who tag small bluefin suggests that tagging mortality for this method is low. Return rates from purse seine tagging are improved when only a few fish are tagged from each set, or when the pursing of the net is delayed while tagging is taking place. In Canadian waters, releases of large bluefin from trap catches have yielded higher return rates than those from rod and reel catches. Swordfish tagged while swimming free have been recaptured at much higher rates than those tagged from longline catches. Return rates for tuna tagged from longline catches have also been low, with one exception. Istiophorid fishes tagged after capture by rod and reel have likewise been recaptured at low rates. The concentration of successful tagging among a small number of cooperators indicates that tagging mortality may be a factor in causing this low rate, but there are strong indications that low fishing pressure is the primary cause. Evidently it is preferable to tag small tunas from hook and line catches and large ones from net catches. Swordfish should be tagged while swimming free, if possible, and the possibilities of this method for marking large tunas and istiophorids should also be investigated.

3.4 Return of tags

All tagging operations depend basically on the efficiency of the return of tags with recapture data. At the suggestion of the Sub-Committee on Stock Identification, ICCAT has offered a prize of $300 for an annual drawing of returned tuna and billfish tags (ICCAT, 1971). This drawing and a standard reward for returned tags are being advertised in posters which will be printed in several appropriate languages and widely distributed. These measures should considerably increase the efficiency of tag return.

3.5 Priorities in tagging

Major tagging efforts should be concentrated on certain key stock components in selected areas, but tagging of other stocks, or stock components, and tagging in other areas, should be continued on an opportunistic basis. Several programmes, particularly those for bluefin tuna, have shown that very important results can be obtained from modest numbers of releases. This fully justifies continued tagging on an opportunity basis, especially of stock components which are not the subjects of major efforts, and in areas where no major efforts are being made. If these objectives can be carried out, the next few years should see great advances in biological knowledge of the Atlantic tunas and billfishes.

Table 1. Releases (after slash) and returns (before slash) 1954-1971 for Atlantic tunas and billfishes, by species and tagging program (abbreviations are as shown in the summary of Atlantic tagging programs).

Agency / Species	FRB(Ca)	ICIT(Cu)	ISTP M(F) ORSTOM(F) MILAB(USA)	FSFRL(J) KPFES(J)	FH(N)	IBM(P)	DF(SA)	IIP(Sp)	AtlantNIRO (USSR)	WHOI(USA) NSFML(USA)	Totals
Thunnus alalunga			48/2353	0/154			0/9		0/12	0/53	48/2581
Thunnus albacares	3/390		4/1678	0/72			0/2			1/472	8 /2614
Thunnus atlanticus		⁄ /1458								1/506	1+/1964
Thunnus obesus	0/20		0/4	0/85					0/5	0/118	0/231
Thunnus thynnus	80/1059		4/30		32/242	0/24		19/312		2199/11,051	234./12,718
Katsuwonus pelamis	4/146	⁄/541	1/1055						0/82	85/2272	90+/4096
Xiphias gladius	13/207									2/57	15/264
Tetrapturus albidus	0/2			0/1						104/8463	104/8466
Makaira nigricans				0/2						5/672	5/674
Istiophorus albicans										94/11,856	94/11,856
Mixed or un-identified tunas	*3/64						0/14				3/78
All years	103/1888	92⁄/1999	57/5119	0/314	32/242	0/24	0/25	19/312	0/99	2491/35,520	2794/45,542

* 3 T. thynnus returned from 60 mixed T. thynnus and K. Pelamis

⁄ 92 returns from T. atlanticus and K. pelamis combined.

Table 2. Releases (after slash) and returns (before slash) for bluefin tuna, Thunnus thynnus, grouped by major tagging localities and seasons. Tagging agencies, methods of capture, and size ranges of fish tagged are also shown. Some releases which do not fit into any of these groups are not listed.

Areas	Norway (west coast)	Portugal (west coast) Bay of Biscay	Spain (Cadizarea)	Cat Cay Bahamas (Straist of Florida)	Cape Hatteras Cape Cod (coastal)	Cape Hatteras Grand Banks (offshore)	Nova Scotia (Halifax area)	Newfound-land (E.coast)
FAO areas	27	27	27	31	21	21	21	21
Tagging agencies	FH(N)	IBM(P) ISTPM(F)	11P(Sp)	WHOI(USA)	FRB(Ca) WHOI(USA) NSFML(USA)	FRB(Ca) WHOI(USA) NSFML(USA)	FRB(Ca)	FRB(Ca) WHOI(USA)
Method of capture	Purse seine	Hook & Line (troll)	Trap	hook & line (troll)	purse seine hook & line	longline	Trap	hook & line (troll)
Season	Aug-Sep	Sep.	May-August	May-June	June-Oct	spring-fall	July-Sept.	July-Oct.
Lengths-cm	150-250	50-60	70-220	190-260	50-150	70-220	200-260	200-260
Years								
1954	-	-	-	0/21	3/169	-	-	-
1955	-	-	-	0/13	0/215	-	-	-
1956	-	-	-	0/40	0/58	-	-	-
1957	0/5	-	-	-	1/34	0/5	-	-
1958	5/20	-	-	-	0/38	-	-	-
1959	10/41	-	-	0/25	0/25	1/97	-	-
1960	6/64	-	9/37	2/13	1/15	2/204	-	-
1961	9/81	-	5/100	2/23	7/150	0/2	-	-
1962	2/13	-	3/51	1/45	4/77	-	-	0/6
1963	-	-	0/24	1/147	9/29	5/42	0/18	0/3
1964	-	-	-	0/41	136/482	1/25	0/6	0/41
1965	-	-	1/50	0/54	300/1938	0/37	3/52	0/47
1966	-	-	-	1/105	1176/3959	0/67	2/71	0/49
1967	-	-	1/50	1/82	186/628	0/8	7/193	0/6
1968	-	2/38	-	0/57	115/260	0/4	-	2/217
1969	-	2/15	-	0/47	107/342	-	1/15	0/195
1970	-	0/1	-	1/182	163/458	-	0/3	1/91
1971	-	-	-	0/49	36/613	-	0/40	0/83
All years	32/242	4/54	19/312	9/944	2244/9491	9/491	13/398	3/738
Percent	13.2	7.4	6.1	1.0	23.6	1.8	3.3	0.4

Table 3. Releases and returns for bluefin tuna 50-150 (mostly 50-100 cm long released by FRB(Ca), WHOI(USA) and NSFML(USA) on the continental shelf between Cape Hatteras, N.C., and Cape Ann, Mass., June-Oct., by year of release, months at liberty, and recapture area*. Seven thousand and sixty-four of these fish were released from purse-seine catches, and the remaining 1827 from hook and line (nearly all trolling) catches. Most of the hook and line releases were by cooperating sport fishermen.

Releases			Returns							
			Number by months at liberty							
Year	Number	Recapture area	0-5.9	6.0-17.9	18.0-29.9	30.0-41.9	42.0-53.9	54.0-65.9	Totals	Percent
1954	169	1	1	0	0	0	0	0	1	0.6
		2	0	0	0	0	0	2	2	1.2
1955	215	-	0	0	0	0	0	0	0	0
1956	58	-	0	0	0	0	0	0	0	0
1957	34	1	0	0	1	0	0	0	1	2.9
1958	38	-	0	0	0	0	0	0	0	0
1959	25	-	0	0	0	0	0	0	0	0
1960	15	1	0	0	1	0	0	0	1	6.7
1961	150	1	0	2	3	2	0	0	7	4.7
1962	77	1	0	4	0	0	0	0	4	5.2
1963	29	1	7	2	0	0	0	0	9	31.0
1964	483	1	100	36	0	0	0	0	136	28.2
1965	1938	1	182	60	37	0	1	0	280	14.4
		2	0	14	5	1	0	0	20	1.0
1966	3959	1	529	569	50	8	4	-	1160	29.3
		2	0	12	3	0	1	-	16	0.4
1967	628	1	97	59	15	13	-	-	184	29.3
		2	0	1	1	0	-	-	2	0.3
1968	260	1	88	19	8	-	-	-	115	44.2
1969	342	1	12	85	10	-	-	-	107	31.3
1970	458	1	50	113	-	-	-	-	163	35.6
1971	613	1	36	-	-	-	-	-	36	5.9
All Years	9491	-	1102	949	125	23	5	0	2204	23.2
" "		2	0	27	9	1	1	2	40	0.4
" "		Totals	1102	976	134	24	6	2	2244	23.6
		Percent	11.6	10.3	1.4	0.3	0.1	0.1	23.6	

*Recapture areas: 1. Release area; 2. Bay of Biscay

Table 4. Landings of small bluefin tuna at St. Jean de Luz, France [1], and from the northwestern Atlantic purse seine tuna fishery [2], and estimated effort [2] of the latter fishery by years.

Years	Landings in Metric Tons		Boat-days
	St. Jean de Luz	NW Atlantic	NW Atlantic
1950	1869		
1951	2893		
1952	2362		
1953	2364		
1954	3451		
1955	3031		
1956	1453		
1957	1550		
1958	1363	168	32
1959	2031	686	31
1960	538	306	22
1961	882	936	96
1962	965	3060	338
1963	543	5370	625
1964	464	5590	909
1965	660	2700	408
1966	1821	790	185
1967	814	2310	186
1968	398	606	84
1969	393	1562	95
1970		4230	281
1971		4625	290

[1] Figures furnished by H. Aloncle of ISTPM (F).

[2] Figures from Wilson, 1965, for 1958-61; remainder collected by WHOI (USA) with the cooperation of the National Marine Fisheries Service and the Inter-American Tropical Tuna Commission.

Table 5. Releases (after slash) and returns (before slash) for albacore, Thunnus alalunga, grouped by major tagging localities and seasons. Tagging agencies, methods of capture, and sizes of fish tagged are also shown.

Area	Northeast Atlantic	Entire Atlantic	Southeast Atlantic	Northwest Atlantic		
FAO Area	27		47	21, 31		
Tagging Agencies	1ST PM(F)	FSFRL(J) KPFES(J)	AtlantNIRO (USSR) DF (SA)	WHOI(USA)	Totals	Percent
Methods of capture	Hook&line (troll)	Longline		Longline		
Season	July-Sept					
Lengths cm.	50-80			60-110		
Years						
1957	-	-		0/1	0/1	0
1958	-	-		-	-	-
1959	-	-		-	-	-
1960	3/400	-		0/14	3/414	0.7
1961	-	-		0/3	0/3	0
1962	-	-		-	-	-
1963	-	-		0/12	0/12	0
1964	-	-		0/20	0/20	0
1965	-	0/44		0/1	0/45	0
1966	-	0/9		0/2	0/11	0
1967	-	-		-	-	-
1968	17/471	0/97		-	17/568	3.0
1969	9/315	0/4		-	9/319	2.8
1970	8/524	-	0/12	-	8/536	1.5
1971	11/643		0/9		11/652	1.7
All years	48/2353	0/154	0/21	0/53	48/2581	1.9
Percent	2.0	0	0	0	1.9	

Table 6. Releases (after slash) and returns (before slash) for yellowfin tuna, Thunnus albacares, grouped by major tagging localities and seasons. Tagging agencies, methods of capture, and size ranges of fish tagged are also shown.

Area	Gulf of Guinea	Entire Atlantic	Northwest Atlantic	Southeast Atlantic	Totals	Per-Cent
FAO areas	34, 47		21, 31	47		
Tagging agencies	FRB(Ca) ORSTOM(F)*	FSFRL(J) KPFES(J)	FRB(Ca) WHOI(USA)	DF(SA)		
Method of capture	Purse seine	Longline	Longline (some hook & line)			
Season	June-May		Mar.-Oct.	June		
Lengths-cm	30-80		60-150			
Years						
1956			0/105		0/105	0
1957		0/28	0/1		0/29	0
1958						
1959						
1960			0/50		0/50	0
1961			0/18		0/18	0
1962			0/3		0/3	0
1963			0/29		0/29	0
1964			0/104		0/104	0
1965		0/14	0/17		0/31	0
1966		0/16	1/25		1/41	2.4
1967	3/378		0/48		3/426	0.7
1968		0/10	0/26		0/36	0
1969		0/4	0/11		0/15	0
1970	0/30		0/12		0/42	0
1971	4/1648	0/0	0/35	0/2	4/1685	
All years	7/2056	0/72	1/484	0/2	8/2614	0.3
Percent	0.3	0	0.2	0	0.3	

*Method of capture and length of fish were not reported for ORSTOM(F) (1970) tagging.

Table 7. Releases (after slash) and returns (before slash) for skipjack tuna, Katsuwonus pelamis, grouped by major tagging localities and seasons. Tagging agencies, methods of capture, and sizes of fish tagged are also shown.

Area	Northeast Atlantic	Cape Verde	Gulf of Guinea	Western Cuba	Northwestern Atlantic		Totals	Per Cent
FAO Area	27	34	34, 47	31	21	21,31		
Tagging Agencies	ISTPM(F)	Atlant NIRO (USSR)	FRB(Ca) ORSTOM(F)* MILAB(USA)	ICIT(Cu)	FRB(Ca) WHOI(USA)	WHOI(USA)		
Methods of Capture	Hook & line (troll)		Purse seine* Live bait	Live bait	Purse seine	Hook & line (troll)		
Season	Aug.-Sept.		June-Aug. November	April-Oct.	July-Sept.			
Length, cm.	40-45		40-80					
Years								
1959				+/541		0/1	+/542	?
1960						0/1	0/1	0
1961						0/10	0/10	0
1962						0/27	0/27	0
1963						0/12	0/12	0
1964					74/761	1/40	75/801	9.4
1965					5/445(+)	0/29	5/474(+)	1.1
1966					7/783	1/21	8/804	1.0
1967			1/37			0/26	1/63	1.
1968	0/35					0/26	0/61	0
1969	0/6	0/82				0/56	0/144	0
1970			0/220			0/102	0/322	0
1971			1/794		0/4	0/37	1/835	0
All years	0/41	0/82	2/1051	+/541	86/1993	2/388	90+/4096(+)	2.2
Per Cent	0	0	0.2	?	4.3	0.5	2.2+	

*Method of capture and sizes of fish were not reported for ORSTOM(F) (Nov. 1970) taggings.

+As of October 30, 1960, 92 returns had been obtained from these releases and 1458 others of blackfin tuna, combined.

(+)Includes 30 of 60 mixed bluefin tuna and skipjack tuna.

Table 8. Releases (after slash) and returns (before slash) for broadbill swordfish Xiphias gladius, grouped by major tagging localities and seasons. Tagging agencies, methods of capture, and sizes of fish tagged are also shown.

Area	Northwest atlantic	Northwest atlantic	Totals	Per Cent
FAO Area	21	21		
Tagging Agencies	FRB(Ca) NSFML(USA) WHOI(USA)	FRB(Ca) WHOI(USA)		
Methods of Capture	Longline	Free swimming		
Season	Apr.-Nov.	July-August		
Length, cm.	90-260	150-250		
Years				
1961	0/3		0/3	0
1962	0/1		0/1	0
1963	0/1		0/1	0
1964	1/34		1/34	2.9
1965	1/28		1/28	3.6
1966	1/26	0/2	1/28	3.6
1967	0/20		0/20	0
1968	0/7	5/20	5/27	18.5
1969	1/28		1/28	3.6
1970	0/44	6/41	6/85	7.1
1971	0/9		0/9	0
All years	4/201	11/63	15/264	5.7
Percent	2.0	17.5	5.7	

Table 9. Releases (after slash) and returns (before slash) for white marlin, Tetrapturus albidus, grouped by major tagging localities. Nearly all were caught on rod and reel (trolling) and tagged by sportfishermen cooperating with WHOI (USA).

YEARS	AREA								TOTALS
	Hatteras to Chesapeake	Chesapeake to Barnegat	Barnegat to Cape Cod	Oceanic North Atlantic	SE Florida and W. Bahamas	West Indies and Vicinity	Gulf of Mexico	Venezuela and Vicinity	
1954			0/4						0/4
1955		1/116				0/8	0/21		1/145
1956		1/402				0/3	0/8		1/413
1957	0/3	0/140	0/1	0/1					0/145
1958	0/1	0/39	0/1						0/41
1959		0/190	0/10					0/2	0/202
1960		0/96	0/2		0/4	0/1	0/4	0/4	0/111
1961	0/2	2/187	0/10		0/13	0/9	0/11	0/30	2/262
1962	0/30	4/294	0/18		0/41		0/4		4/387
1963	0/75	4/533	0/4	0/3	0/35		0/10		4/660
1964	4/182	8/258	0/1	0/5	1/67		0/13		13/526
1965	0/15	6/258	0/5		0/67	0/5	0/10	2/25	8/385
1966	1/36	9/172	1/64	0/6	1/54	0/4	0/23	2/149	14/508
1967	0/37	4/234	0/6		0/88	0/7	1/46	0/103	5/521
1968	2/100	14/569	1/32		1/95	0/16	0/56	0/16	18/884
1969	6/359	8/829	0/27		1/86	0/18	2/35	2/46	19/1400
1970	5/320	3/463	0/55		1/49	0/15	0/28	0/17	9/947
1971	1/212	0/532	0/17		0/53	0/17	0/16	0/27	1/874
Unknown	2/2	2/2							4/4
TOTALS	21/1374	66/5314	2/257	0/15	5/652	0/103	3/285	6/419	103/8419

Table 10. Releases for white marlin, Tetrapturus albidus, in the western North Atlantic by years, and returns from these by months at liberty.

Releases Year	Releases Number	Months at large					Totals
		0-5.9	6.0-17.9	18.0-29.9	30.0-41.9	42.0-59.9	
1954	4						0
5	145					1	1
6	413		1				1
7	145						0
8	41						0
9	202						0
1960	111						0
1	262				2		2
2	387		1	1	1	1	4
3	660	1	2	1	0	0	4
4	526	3	5	4	0	1	13
5	385	2	4	1	1	0	8
6	508	4	2	4	1	3	14
7	521	0	2	2	1	-	5
8	884	1	10	4	3	-	18
9	1400	6	11	2	-	-	19
1970	947	4	5	-	-	-	9
1	874	1	-	-	-	-	1
Totals	8419*	22	43	19	9	6	103*

*Totals include 4 releases and returns not shown in breakdown by years because release date is not known.

Table 11. Releases (after slash) and returns (before slash) for Atlantic sailfish, Istiophorus albicans, grouped by major tagging localities. Nearly all were caught on rod and reel (trolling) and tagged by sportfishermen cooperating with WHOI (USA).

Year	Hatteras Delaware	NE Florida	SE Florida	Bahamas	Gulf of Mexico Fla. & La.	Gulf of Mexico Texas	Haiti & Virgin Is.*	SE Caribbean	Yucatan	Totals
1954			0/27							0/27
1955			1/15		0/1					1/16
1956										0
1957			0/17			0/7				0/24
1958			2/7			0/21				2/28
1959			0/72		0/1	0/33		0/7		0/113
1960	0/2		5/746	0/4	0/3	0/22	0/5	0/44	0/1	5/827
1961	0/1	0/1	5/949	0/9	0/5	0/182	1/3	0/7		6/1157
1962	0/2	0/4	10/1141	0/32	0/3	0/93	0/9			10/1284
1963	0/4		9/1000	0/45	0/1	0/102			0/10	9/1162
1964	0/2		6/925	0/73	0/9	0/60	0/5		0/6	6/1080
1965	0/1	0/3	7/928	1/34		0/95	1/17	0/15		9/1093
1966	0/2	0/1	9/565	0/57	0/4	0/152	1/150	7/186	0/22	17/1139
1967	0/1	1/2	6/386	1/33	2/52	0/188	3/67	0/53	0/46	13/828
1968			6/420	2/43	1/220	1/54	0/20	0/3	0/15	10/775
1969	1/15		3/339	0/71	1/24	0/154	0/53	0/60	0/47	5/763
1970	0/28	0/2	1/254	0/38	0/71	0/73	0/47	0/32	0/76	1/621
1971	0/19	0/1	0/332	0/39	0/31	0/63	0/44	0/10	0/349	0/888
Totals	1/77	1/14	70/8123	4/478	4/425	1/1289	6/420	7/417	0/572	94/11,825

4. GENERAL BIBLIOGRAPHY OF TUNA AND BILLFISH TAGGING

Agger, P., 1970 Marcaciones de peces: un instrumento de la investigación pesquera. Mar Pesca, (53):26-9

Akyüz, E.F., 1970 A guide to marks used for tunas and an inventory of tuna marking projects. FAO Fish.Circ., (101) Rev. 1: 119 p.

Allain, C., 1967 Etude sur le comportement du germon en fonction des conditions hydrologiques. Sci.Pêche,Bull.Inst.Sci.Tech.Pêches Marit., (164/165): 3-16

Allain, C. and H. Aloncle, 1968 Migrations du germon en fonction des variations thermiques du milieu entre le secteur Portugaise et le So de l'Irlande. Sci.Pêche,Bull.Inst. Sci.Tech.Pêches Marit., (176): 15 p. Issued also as Transl.Trop.Atl.Biol.Lab. Bur.Commer.Fish.Miami Fla., (20):13 p.

Aloncle, H. and F. Delaporte, 1970 Recherches sur le germon (Campagnes 1969 de "LA PELAGIA"). Sci.Pêche,Bull.Inst.Sci.Tech.Pêches Marit., (191):10 p.

_____, 1971 Recherches sur le germon (Campagnes 1970 de "LA PELAGIA"). Sci.Pêche,Bull. Inst.Sci.Tech.Pêches Marit., (199): 9 p.

_____, 1971a Migration du germon du N.E. Atlantique. ICCAT/SCRS/71/39

Arena, P., 1959 A proposito di un arpione rinvenuto su un tonno pescato in Tunisia e descritto da Heldt nel 1932. Arpione in uso nello Stretto di Messina. Boll.Pesca Piscic. Idrobiol., 14(1): 95-9

Arena, P. and R. Sara, 1965 Relazione sulla campagna di marcatura dei tonni. Centro Sperimentale per l'Industria e dei Prodotti del Mare, Regione Siciliana. 25 p.

_____, 1965 Campagna di marcatura dei tonni, 1965. Suppl.Boll.Inf.Siciloam., 4:15-25

Beckett, J.S., 1968 A harpoon adapter for tagging large free-swimming fish at the surface. J.Fish.Res.Board Can., 25(1): 177-9

_____, 1970 Swordfish, shark and tuna tagging 1961-1969. Tech.Rep.Fish.Res.Board Can., (193): 13 p.

C.I.E.S.M.M., 1932 Procès-verbaux de la conférence d'experts pour l'examen des méthodes scientifiques à appliquer à l'étude des poissons de la famille des thonidés. Madrid et Cadix 16-22 Mai 1932. Rapp.P.-V.Réun.Comm.Int.Explor.Sci.Mer Méditerr., 7: 47-90

De Silva, D.P., 1957 Studies of the age and growth of the Atlantic sailfish, Istiophorus americanus (Cuvier), using length frequency curves. Bull.Mar.Sci. Gulf Caribb. 7(1):1-20

Dwivedi, S.N., 1964 Migration du thon rouge Thunnus thynnus (Linné). Sci.Pêche,Bull.Inst.Sci. Tech.Pêches Marit., (131):9 p.

Earle, S., 1940 The white marlin fishery of Ocean City, Maryland. Spec.Sci.Rep.U.S.Fish Wildl. Serv., (6):15 p.

FAO, 1964 Report of the first session of the FAO Expert Panel for the Facilitation of Tuna Research, Rome 8-12 June 1964. FAO Fish.Rep., (18):23 p.

_____, 1966 Report of the second session of the FAO Expert Panel for the Facilitation of Tuna Research, Tokyo 15-21 August 1966. FAO Fish.Rep., (37):64 p.

_____, 1968 Report of the meeting of a group of experts on tuna stock assessment (under the FAO Expert Panel for the Facilitation of Tuna Research). Miami, U.S.A., 12-16 August 1968. FAO Fish.Rep., (61):45 p.

_____, 1969 Report of the third session of the FAO Expert Panel for the Facilitation of Tuna Research. Cadiz, Spain, 7-10 October 1969. FAO Fish.Rep., (80):93 p.

Fishery Agency of Japan, Research Division, 1965-71 Annual report of effort and catch statistics by area on Japanese tuna long line fishery 1962: 183 pp., 1963: 322 pp., 1964: 379 pp., 1965: 375 pp., 1966: 299 pp., 1967: 293 pp., 1968: 283 pp., 1969: 299 pp.

Frade, F. and S. Dentinho, 1935 Marcação de atuns na costa do Algarve. Contribuição portuguesa para o estudo dos movimentos migratórios do atun (Thunnus thynnus L.). Bull. Soc.Port.Sci.Nat., 12(10):63-9

Hamre, J., 1959 The tuna tagging experiments in Norwegian waters. ICES Scombriform Fish Committee, No. (92):3 p.

_____, 1960 Tuna investigation in Norwegian coastal waters 1954-1958. Ann.Biol.,Copenh., 15:197-211

_____, 1961 The Norwegian tuna investigations in 1959. Ann.Biol.,Copenh., 16:235-40

_____, 1961a Some results of the Norwegian bluefin tuna investigations. ICES Scombriform Fish Committee, No. (90):7 p.

_____, 1962 Tuna tagging experiments in Norwegian waters. Paper presented to the World Scientific Meeting on the Biology of Tunas and Related Species, La Jolla, California, 2-12 July 1962. Also in FAO Fish.Rep., (6), vol. 3:1125-32, 1963

_____, 1962a The Norwegian tuna investigations, 1960. Ann.Biol.,Copenh., 17:231-5

_____, 1963 The Norwegian tuna investigations, 1961. Ann.Biol.,Copenh., 18:197-203

_____, 1964 Observations on the depth range of tagged bluefin tuna based on pressure marks on the Lea tag. ICES Scombriform Fish Committee, No. (151): 5 p.

_____, 1965 The Norwegian tuna investigations, 1962-1963. Ann.Biol.,Copenh., 20:232-6

Hamre, J. et al., 1965 Report from the bluefin tuna working group. On the development of the bluefin tuna fisheries from 1950-1964 and further observations on the size composition of bluefin tuna catches. ICES Scombriform Fish Committee, No. (46): 12 p.

Hamre, J. et al., Report of bluefin tuna working group. Observations on the size-composition
1968 of bluefin tuna catches from 1967. ICES Pelagic Fish (Southern) Committee, (J: 3):15 p.

_____, Report from the bluefin tuna working group. Observations on the size
1970 composition of bluefin catches from 1969. ICES Pelagic Fish (Southern) Committee, (J: 2):14 p.

Hayasi, S. et al., Status of the tuna fisheries resources in the Atlantic Ocean, 1956-67.
1970 In Resources and fisheries of tunas and related fishes in the Atlantic Ocean. S.Ser.Far Seas Fish.Res.Lab., (3):1-72

Heldt, H., Le thon rouge et sa pêche. Rapp.P.-V.Réun.Comm.Int.Explor.Sci.Mer Méditerr.,
1929 4:97-112

_____, Le thon rouge et sa pêche. Rapp.P.-V.Réun.Comm.Int.Explor.Sci.Mer Méditerr.,
1930 5:131-72

_____, Le thon rouge et sa pêche. Rapp.P.-V.Réun.Comm.Int.Explor.Sci.Mer Méditerr.,
1931 6:175-288

_____, Rapport sur le thon rouge et sa pêche. Rapp.P.-V.Réun.Comm.Int.Explor.Sci.
1932 Mer Méditerr., 7:203-318

_____, Le thon rouge et sa pêche. Rapp.P.-V.Réun.Comm.Int.Explor.Sci.Mer Méditerr.,
1934 8:185-255

_____, Le thon rouge et sa pêche, rapport pour les années 1933, 1934, et 1935
1937 (9e. rapport). Rapp.P.-V.Réun.Comm.Int.Explor.Sci.Mer Méditerr., 10:235-315

_____, Le thon rouge et sa pêche. Rapp.P.-V.Réun.Comm.Int.Explor.Sci.Mer Méditerr.,
1938 11:311-58

_____, Etudes sur le thon, la daurade et les muges. Histoires d'écailles et
1943 d'hameçons. Broch.Stn.Océanogr.Salammbô, (1):3-47

ICCAT, Report of the meeting of the Sub-Committee on Stock Identification under the
1971 Standing Committee on Research and Statistics, International Commission for the Conservation of Atlantic Tunas, Lisbon, 5-9 April 1971, 39 p.

_____, Report of the Standing Committee on Research and Statistics. ICCAT/CON/70/39.
1971a Biennial Period 1970-71, Part 2:47-80

ICES, Compte-rendu de la conférence d'experts pour l'examen des méthodes scientifiques et
1933 techniques à appliquer à l'etude des poissons de la famille des thonidés. Rapp. P.-V.Réun.Cons.Perm.Int.Explor.Mer, 84(3):91-103

Le Gall, J., Attention aux poissons marqués. Bull.Off.Pêches Marit.,(B), (38)
1951

Letaconnoux, R., Résultat de marquages de thons effectués en 1950-1960 dans le Golfe de
1961 Gascogne. C.I.E.S.M.M, 1961, 1 p.

_____, A note on the tagging of long-finned tunny in the Bay of Biscay. ICNAF Spec.
1963 Publ., 4(54):327

_____, Rapport de recherche (France). Note sur la pêche du germon. ICCAT/CON/70/16
1970

Letaconnoux, R., Report of investigation in France. In ICCAT Report, Biennial Period
1971 1970-71 Part 2:90-2

Macmillan, G., Tagging report. Underwater Naturalist,7(1):36-7
1971

Mather, F.J. III, Recaptures of tuna, marlin, and sailfish tagged in the western North
1960 Atlantic. Copeia, (2):149-51. Also issued in Contrib.Woods Hole Oceanogr.Inst., (1092)

_____, Tons of tuna. Closing a gap in our knowledge. Oceanus, 7(3):15-9
1961

_____, Transatlantic migration of two large bluefin tuna. J.Cons.Perm.Int.Explor.
1962 Mer, 27(3):325-7

_____, Distribution and migrations of North Atlantic bluefin tuna. Proc.Int.Game
1962a Fish.Conf., 7:7 p.

_____, Tags and tagging techniques for large pelagic fishes. Spec.Publ.Int.Comm.
1963 North Atl.Fish., 4(46):288-93

_____, Game fish migrations. Oceanus, 10(2):16-19
1963a

_____, Cooperative game fish tagging. Proc.Int.Game Fish.Conf., 10
1965

_____, Tunas (genus Thunnus) of the western North Atlantic. Part 3. Distribution
1967 and behaviour of Thunnus species. Symp.Ser.Mar.Biol.Ass.India, 1 (1):411-26. Abstract published in FAO Fish.Rep., 6(3):1159-61, (1963)

_____, The trail of the tail-walker. Oceanus, 13(2/3):10-6. Also issued as Proc.
1967a Int.Game Fish.Conf., 10:20-4

_____, The Atlantic bluefin tuna situation. Sportfishing, 4(12):55
1968

_____, They went thataway. Salt Water Sportsman, 29(7):40-3, 72-3
1968a

_____, Tracking the tail-walker. Sportfishing, 4(6):28-9, 42, 45
1968b

_____, Long distance migrations of tunas and marlins. Underwater Naturalist,
1969 6(1):6-14, 46

Mather, F.J. III and M.R. Bartlett, Bluefin tuna concentration found during a long-line
1962 exploration of the northwestern Atlantic slope. Commer.Fish.Rev., 24(2):1-7

Mather, F.J. III, M.R. Bartlett and J.S. Beckett, Transatlantic migrations of young bluefin
In press tuna. J.Fish.Res.Board Can., 29(0):1991-7

Mather, F.J. III, A.C. Jones and J.L. Beardsley, Jr., Migration and distribution of white
In press marlin and blue marlin in the Atlantic Ocean. Res.Rep.Bur.Sport.Fish.Wildl.

Mather, F.J. III and H.A. Schuck, Growth of bluefin tuna of the western North Atlantic.
1960 Fish.Bull.U.S., 61(179):39-52

Mather, F.J. III, et al., 1969 Interim report of working party on tuna tagging in the Atlantic and adjacent seas. FAO Fish.Rep., (80):50-69

Postel, E., 1970 Les migrations à longue distance du thon rouge. Pêche Marit., 1110:647-9

Rivas, L.R., 1955 A comparison between giant bluefin tuna (Thunnus thynnus) from the Straits of Florida and the Gulf of Maine, with reference to population identity. Proc. Gulf Caribb.Fish.Inst., 1954, 7th session:133-49

Rodríguez-Roda, J., 1959 Aparición en la costa sudatlántica española de atunes marcados en Noruega. Invest.Pesq., 14:115-20

_____, 1960 Marcación de atunes, Thunnus thynnus (L.) en el Golfo de Cádiz. In Fourth meeting on the Productivity of the sea and fisheries exploitation. Barcelona, Instituto de Investigaciones Pesqueras, pp. 89-90

_____, 1960a Spanish research on tuna. ICES. Scombriform.Fish.Committee Commun., (188):4 p. (SS/12a)

_____, 1963 Investigaciones sobre tunidos. Publ.Téc.Junta Estud.Pesca, (2):39-77

_____, 1963a Resultado del programa de marcado de atunes en aguas españolas. FAO Fish. Rep., (6)Vol.3:1813-22

_____, 1964 Movimientos migratorios del atún, Thunnus thynnus (L.), deducidos de nuestras propias "marcaciones" en aguas españolas. Publ.Téc.Junta Estud.Pesca, (3):279-304

_____, 1964a Biología del atún, Thunnus thynnus (L.) de la costa sudatlántica de España. Invest.Pesq., 25:33-146

_____, 1966 Continuación del plan de marcación de atunes, Thunnus thynnus (L.) en el Golfo de Cádiz, en 1965. Publ.Téc.Junta Estud.Pesca, (5):81-3

_____, 1966a Estudio de los atunes, Thunnus thynnus (L.), capturados en 1965, por la almadraba de Barbate (costa sudatlántica de España). Invest.Pesq., 30:483-96

_____, 1969 Results of tagging experiments on bluefin tuna Thunnus thynnus (L.) in the Gulf of Cadiz (Spain). FAO Fish.Rep., (68):40(abstract only)

_____, 1969a Resultados de nuestras marcaciones de atunes en el Golfo de Cádiz durante los años 1960 a 1967. Publ.Téc.Junta Estud.Pesca, (8):153-8

_____, 1969b Marcaciones españolas de atunes, Thunnus thynnus, en el Golfo de Cádiz. Third Session FAO Expert Panel for the Facilitation of Tuna Research, Cadiz, Spain, 7-11 October 1969

_____, 1970 Principales características estudiadas en el atún, Thunnus thynnus (L.), del Golfo de Cádiz y capturados por las almadrabas españolas. ICCAT/CON/70/20

_____, 1971 Investigations of tuna (Thunnus thynnus) in Spain. In ICCAT Report Biennial Period 1970-71, Part 2:110-3

Russell, F.S., 1934 Tunny investigations made in the North Sea on Col. E.T. Peel's yacht "St. George" summer 1933, Part I. Biometric data. J.Mar.Biol.Ass.U.K., 19(2):503-22

Sella, M., 1926 Le migrazioni dei tonni studiate per mezzo degli ami. Rend.Accad.Lincei (6a), 3, 1 sem., fasc. 11:5 p.

_____, 1926a Altri fatti sopra le migrazioni dei tonni accertati per mezzo degli ami. Rend.Accad.Lincei (6a), 4, 2 sem., fasc. 5-6:4 p.

_____, 1927 Is the tuna an international wanderer? Can.Fisherman, 14(3):81-2

_____, 1927a Les migrations des thons étudiées par le moyen des hameçons. Bull.Stn.Agric. Pêche Castiglione, fasc. 2:101-36

_____, 1929 Migrazioni e habitat del tonno (Thunnus thynnus L.) studiati col metodo degli ami, con osservazioni sull'accrescimento, sul regime delle tonnare ecc. R.C.Com. Talassogr.Ital.Mem., (156):24 p. Also issued as Spec.Sci.Rep.U.S.Fish Wildl. Serv.(Fish.), (76):20 p.(1952). Transl. by W.G. Van Campen

_____, 1930 Distribution and migrations of the tuna (Thunnus thynnus L.) studied by the method of hooks, and other observations. Int.Rev.Hydrobiol., 24:446-66

_____, 1931 The tuna (Thunnus thynnus L.) of the western Atlantic. An appeal to fishermen for the collection of hooks found in tuna fish. Int.Rev.Hydrobiol., 25(1/2):46-7

_____, 1932 Sulle migrazioni del tonno (Thunnus thynnus L.). Estr.Conv.Biol., (1):103

_____, 1932a Studio sul tonno. Conferenza sulla pesca del tonno. Boll.Pesca Piscic. Idrobiol., 8(1):68-73

_____, 1932b Il tonno. Conferenza. Note Ist.Biol.Mar.Rovigno, (3):3-24

Suárez-Caabro, J.A. and P.P. Duarte Bello, 1961 Biología pesquera de bonito (Katsuwonus pelamis) y la albacora (Thunnus atlanticus) en Cuba. 1. Ser.Estud.Invest.Inst.Cubano Tecnol.Invest., (15):151 p.

Tibbo, S.N. and J.S. Beckett, 1971 Canadian research report, 1969-70. In ICCAT Report. Biennial Period 1970-71, Part 2:85-9

Tiews, K., 1963 Synopsis of biological data on bluefin tuna Thunnus thynnus (Linnaeus) 1758 (Atlantic and Mediterranean). FAO Fish.Rep., (6), vol. 2:422-81

_____, 1964 Der Thunbestand Thunnus thynnus (Linnaeus) in der Nordsee, seine Wanderungen, seine transatlantischen Beziehungen und seine Nutzung durch die deutsche Fischerei. Arch.Fischereiwiss., 14:105-48

Westman, J.R. and W.C. Neville, 1942 The tuna fishery of Long Island. New York, Board of Supervisors, Nassau County, 30 p.

Wilson, P.C., 1965 Review of the Development of the Atlantic Coast Tuna Fishery. Commer.Fish. Rev., 27(3):1-10

Wilson, R.C., 1953 Tuna marking, a progress report. Calif.Fish Game, 39(4):429-42

Wise, J.P., G.L. Beardsley, Jr. and F.J. Mather, III, United States research report to the
1971 first regular meeting of the ICCAT Council. In ICCAT Report, Biennial Period 1970-71, Part 2:pp. 117-20

Anon. Game fish studies. Oceanus,6(4):9
1960

_____, Tagged bluefin tuna cross Atlantic. Commer.Fish.Rev., 22(3):19-20
1960a

_____, Bluefin tuna swim 4 500 miles in 119 days. Oceanus,8(2):23
1961

_____, Results of bluefin tagging in Atlantic by Woods Hole Oceanographic
1964 Institution. Commer.Fish.Rev., 26(2):54

* * * * * * *

MR/D1940/9.72/E/1/1000